

WHAT IS CLAIMED IS:

1. A method of controlling the release rate of an agricultural active ingredient from a seed treated with the active ingredient, the method comprising the steps of:

5 providing a seed that has been treated with an agricultural active ingredient;

applying to the treated seed a film comprising an emulsion of a polymer in a liquid in which both the agricultural active ingredient and the polymer have low levels of solubility; and

10 curing the film to form a water insoluble polymer coating on the surface of the treated seed.

2. The method according to claim 1, wherein the liquid is water.

3. The method according to claim 2, wherein the ratio of the weight of the film to the weight of the treated seed is from about 1:10 to about 1:50, and the weight percent of the polymer in the film at the time the film is applied to the seed is from about 0.5 percent to about 25 percent.

4. The method according to claim 3, wherein the ratio of the weight of the film to the weight of the treated seed is from about 1:16 to about 1:22, and the weight percent of the polymer in the film at the time the film is applied to the seed is from about 4 percent to about 15 percent.

5. The method according to claim 4, wherein the ratio of the weight of the film to the weight of the treated seed is from about 1:18 to about 1:21, and the weight percent of the polymer in the film at the time the film is applied to the seed is from about 5 percent to about 11 percent.

6. The method according to claim 2, wherein the film additionally comprises a non-migrating surfactant.

7. The method according to claim 6, wherein the water insoluble polymer and the non-migrating surfactant and the relative amounts of each are selected so that the polymer coating that is formed from the water insoluble polymer and the non-migrating surfactant has a glass transition temperature within a pre-selected range, thereby providing

a coating which retards the release rate of the agricultural active ingredient from the seed by a desired amount.

5 8. The method according to claim 7, wherein the glass transition temperature of the polymer coating is within the range of from about -5°C to about 75°C.

 9. The method according to claim 8, wherein the glass transition temperature of the polymer coating is within the range of from about 10°C to about 50°C.

10 10. The method according to claim 9, wherein the glass transition temperature of the polymer coating is within the range of from about 15°C to about 40°C.

 11. The method according to claim 10, wherein the glass transition temperature of the polymer coating is within the range of from about 15°C to about 25°C.

15 12. The method according to claim 3, wherein the agricultural active ingredient is a pesticide.

 13. The method according to claim 12, wherein the pesticide is selected from the group consisting of herbicides, insecticides, acaracides, fungicides, nematocides, and bactericides.

20 14. The method according to claim 13, wherein the agricultural active ingredient is an insecticide.

 15. The method according to claim 14, wherein the agricultural active ingredient is selected from the group consisting of pyrethrins including, 2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one ester of 2,2-dimethyl-3-(2methyl propenyl)-cyclopropane carboxylic acid, and/or (2-methyl-1-propenyl)-2-methoxy-4-oxo-3-(2 propenyl)-2-cyclopenten-1-yl ester and mixtures of cis and trans isomers thereof; synthetic pyrethroids including (s)-cyano(3-phenoxyphenyl)methyl-4-chloro-alpha-(1-methylethyl)benzeneacetate (fenvalerate), (S)-cyano (3-phenoxyphenyl)methyl (S)-4-chloro-alpha-(1-methylethyl)benzeneacetate (esfenvalerate), (3-phenoxyphenyl)-methyl(+)-cis-trans-3-(2,2-dichoroethenyl)-2,2-dimethylcyclopropanecarboxylate (permethrin), (±)

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alpha-cyano-(3-phenoxyphenyl)methyl(+)-cis,trans-3-(2,2-dichloroethenyl)-
2,2-dimethyl-cyclopropanecarboxylate (cypermethrin), beta-cypermethrin,
theta cypermethrin, S-cyano (3-phenoxyphenyl)methyl (±) cis/trans 3-(2,2-
dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate (zeta-
5 cypermethrin), (s)-alpha-cyano-3-phenoxybenzyl (1R,3R)-3-(2,2-
dibromovinyl)-2,2-dimethylcyclopropanecarboxylate (deltamethrin), alpha-
cyano-3-phenoxybenzyl-2,2,3,3,-tetramethyl cyclopropoanecarboxylate
(fenpropathrin), (RS)-alpha-cyano-3-phenoxybenzyl(R)-2-[2-chloro-4-
(trifluoromethyl)anilino]-3-methylbutanoate (tau-fluvalinate), (2,3,5,6-
10 tetrafluoro-4-methylphenyl)-methyl-(1-alpha, 3-alpha)-(Z)-(±)-3-(2-chloro-
3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate
(tefluthrin), (±)-cyano-(3-phenoxyphenyl)methyl (±)-4-(difluoromethoxy)-
alpha-(1-methylethyl)benzeneacetate (flucythrinate), cyano(4-fluoro-3-
phenoxyphenyl)methyl 3-[2-chloro-2-(4-chlorophenyl)ethenyl]-2,2-
15 dimethylcyclopropanecarboxylate (flumethrin), cyano(4-fluoro-3-
phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethyl-
cyclopropanedacboxylate (cyfluthrin), beta cyfluthrin, transfluthrin, (S)-
alpha-cyano-3-phenoxybenzyl(Z)-(1R-cis)-2,2-dimethyl-3-[2-(2,2,2-
trifluoro-trifluoromethyl-ethoxycarbonyl)vinyl]cyclopropane carboxylate
20 (acrinathrin), (1R cis) S and (1S cis) R enantiomer isomer pair of alpha-
cyano-3-phenoxybenzyl-3-(2,2-dichlorovinyl)-2,2-
dimethylcyclopropanecarboxylate (alpha-cypermethrin),
[1R,3S]3(1'RS)(1',2',2',2'-tetrabromoethyl)]-2,2-dimethyl
cyclopropanecarboxylic acid (s)-alpha-cyano-3-phenoxybenzyl ester
25 (tralomethrin), cyano-(3-phenoxyphenyl)methyl-2,2-dichloro-1-(4-
ethoxyphenyl)cyclopropanecarboxylate (cycloprothrin), [1 α , 3 α (Z)]-(±)-
cyano-(3-phenoxyphenyl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-
dimethylcyclopropanecarboxylate (cyhalothrin), [1-alpha (s), 3-alpha(z)]-
cyano(3-phenoxyphenyl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-
30 dimethylcyclopropanecarboxylate (lambda cyhalothrin), (2-methyl [1,1'-
biphenyl]-3-yl)methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-
cyclopropanecarboxylate (bifenthrin), 5-1-benzyl-3-furylmethyl-d-

cis(1R,3S,E)2,2-dimethyl-3-(2-oxo,-2,2,4,5-tetrahydrothiophenylidenemethyl)cyclopropane carboxylate (kadethrin), [5-(phenylmethyl)-3-furanyl]-3-furanyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate (resmethrin). (1R-trans)-[5-(phenylmethyl)-3-furanyl]methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate (bioresmethrin), 3,4,5,6-tetrahydrophthalimidomethyl-(1RS)-cis-trans-chrysanthemate (tetramethrin), 3-phenoxybenzyl-d,1-cis,trans 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylate (phenothrin), empenethrin, cyphenothrin, prallethrin, imiprothrin, (RS)-3-allyl-2-methyl-4-oxocyclopent-2-enyl-(1S,3R; 1R,3S)-2,2-dimethyl-3-(2-methylprop-1-enyl) cyclopropane carboxylate (allethrin), bioallethrin, and ZXI8901; oxadiazine derivatives including 5-(2-chloropyrid-5-ylmethyl)-3-methyl-4-nitroiminoperhydro-1,3,5-oxadiazine, 5-(2-chlorothiazol-5-ylmethyl)-3-methyl-4-nitroiminoperhydro-1,3,5-oxadiazine, 3-methyl-4-nitroimino-5-(1-oxido-3-pyridinomethyl)perhydro-1,3,5-oxadiazine, 5-(2-chloro-1-oxido-5-pyridiniomethyl)-3-methyl-4-nitroiminoperhydro-1,3,5-oxidiazine, 3-methyl-5-(2-methylpyrid-5-ylmethyl)-4-nitroiminoperhydro-1,3,5-oxadiazine, and thiamethoxam; chloronicotiny insecticides including acetamiprid ((E)-N-[(6-chloro-3-pyridinyl)methyl]-N'-cyano-N-methyleneimidamide), imidacloprid (1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimide), and nitenpyram (N-[(6-chloro-3-pyridinyl)methyl]-N-ethyl-N'-methyl-2-nitro-1,1-ethenediamine); nitroguanidine, including TI-435; pyrroles; pyrazoles chlorfenapyr (4-bromo-2-(4-chlorophenyl)-1-ethoxymethyl-5-trifluoromethylpyrrole-3-carbonitrile), fenpyroximate ((E)-1,1-dimethylethyl-4-[[[(1,3-dimethyl-5-phenoxy-1H-pyrazole-4-yl)methylene]amino]oxy]methyl]benzoate), and tebufenpyrad (4-chloro-N[[4-1,1-dimethylethyl]phenyl]methyl]-3-ethyl-1-methyl-1H-pyrazole-5-carboxamide); phenyl pyrazoles including fipronil (5-amino-[2,6-dichloro-4-(trifluoromethyl)phenyl]-4-[(1R,S)-(trifluoromethyl)sulfinyl]-1H-pyrazole-3-carbonitrile); diacylhydrazines including halofenozide (4-chlorobenzoate-2-benzoyl-2-(1,1-dimethylethyl)-hydrazide), methoxyfenozide (RH-2485, N-

tert-butyl-N'-(3-methoxy-o-toluoyl)-3,5-xylohydrazide), and tebufenozide (3,5-dimethylbenzoic acid 1-(1,1-dimethylethyl)-2,(4-ethylbenzoyl)hydrazide); triazoles including amitrole and triazamate; biological/fermentation products including avermectin (abamectin) and spinosad (XDE-105); organophosphate insecticides including acephate, chlorpyrifos, chlorpyrifos-methyl, diazinon, fenamiphos, and malathion; and carbamate insecticides including aldicarb, carbaryl, carbofuran, oxamyl, and thiodicarb.

16. The method according to claim 15, wherein the agricultural active ingredient is imidacloprid.

17. The method according to claim 13, wherein the agricultural active is a fungicide selected from the group consisting of tebuconazole, simeconazole, fludioxonil, fluquinconazole, difenoconazole, 4,5-dimethyl-N-(2-propenyl)-2-(trimethylsilyl)-3-thiophenecarboxamide (silthiopham), hexaconazole, etaconazole, propiconazole, triticonazole, flutriafol, epoxiconazole, fenbuconazole, bromuconazole, penconazole, imazalil, tetraconazole, flusilazole, metconazole, diniconazole, myclobutanil, triadimenol, bitertanol, pyremethanil, cyprodinil, tridemorph, fenpropimorph, kresoxim-methyl, azoxystrobin, ZEN90160, fenpiclonil, benalaxyl, furalaxyl, metalaxyl, R-metalaxyl, orfurace, oxadixyl, carboxin, prochloraz, triflumizole, pyrifenox, acibenzolar-S-methyl, chlorothalonil, cymoxanil, dimethomorph, famoxadone, quinoxifen, fenpropidine, spiroxamine, triazoxide, BAS50001F, hymexazole, pencycuron, fenamidone, guazatine, and cyproconazole.

18. The method according to claim 6, wherein the film substantially covers the surface of the seed.

19. The method according to claim 15, wherein the step of providing a seed that has been treated with an agricultural active ingredient comprises treating the seed with the agricultural active ingredient.

20. The method according to claim 19, wherein the step of treating the seed with the agricultural active ingredient comprises

contacting the seed with the active prior to applying the film comprising an emulsion of a polymer in water.

21. The method according to claim 20, wherein the amount of active that is applied to the seed is between about 0.5 gm of active ingredient / 100 kg of seed and 1000 gm / 100 kg of seed.

22. The method according to claim 20, wherein the amount of active that is applied to the seed is between about 25 gm of active /100 kg of seed and 600 gm / 100 kg of seed.

23. The method according to claim 22, wherein the amount of active that is applied to the seed is between 50 gm/ 100 kg of seed and 400 gm / 100 kg of seed.

24. The method according to claim 21, wherein the active is applied to the seed in the form of a liquid suspension.

25. The method according to claim 24, wherein the active is present in the liquid suspension in the form of particles having an average size of less than about 10 microns.

26. The method according to claim 25, wherein the active is present in the liquid suspension in the form of particles having an average size of less than about 2 microns.

27. The method according to claim 25, wherein the active is present in the liquid suspension in a concentration of between about 0.1% and about 50%, by weight.

28. The method according to claim 27, wherein the active is present in the liquid suspension in a concentration of between about 0.5% and 15%, by weight.

29. The method according to claim 28, wherein the active is present in the liquid suspension in a concentration of between about 1% and 3%, by weight.

30. The method according to claim 1, wherein the liquid is non-aqueous.

31. The method according to claim 1, wherein the liquid is an aqueous/ non-aqueous mixture.

32. The method according to claim 2, wherein the seed is the seed of a plant selected from the group consisting of corn, peanut, canola/rapeseed, soybean, cucurbits, cotton, rice, sorghum, sugar beet, wheat, barley, rye, sunflower, tomato, sugarcane, tobacco, oats, vegetables, and leaf crops.

33. The method according to claim 32, wherein the seed has a transgenic event.

34. The method according to claim 2, wherein the polymer is selected from the group consisting of polyesters, polycarbonates, copolymers of styrene, and mixtures thereof.

35. The method according to claim 2, wherein the polymer is selected from the group consisting of acrylonitrile-butadiene-styrene terpolymer (ABS); ABS modified polyvinylchloride; ABS-polycarbonate blends; acrylic resins and copolymers: poly(methacrylate), poly(ethylmethacrylate), poly(methylmethacrylate), methylmethacrylate or ethylmethacrylate copolymers with other unsaturated monomers; casein; cellulosic polymers: ethyl cellulose, cellulose acetate, cellulose acetatebutyrate; ethylene vinyl acetate polymers and copolymers; poly(ethylene glycol); poly(vinylpyrrolidone); acetylated mono-, di-, and triglycerides; poly(phosphazene); chlorinated natural rubber; polybutadiene; polyurethane; vinylidene chloride polymers and copolymers; styrene-butadiene copolymers; styrene-acrylic copolymers; alkylvinylether polymers and copolymers; cellulose acetate phthalates; epoxies; ethylene copolymers: ethylene-vinyl acetate-methacrylic acid, ethylene-acrylic acid copolymers; methylpentene polymers; modified phenylene oxides; polyamides; melamine formaldehydes; phenolformaldehydes; phenolic resins; poly(orthoesters); poly(cyanoacrylates); polydioxanone; polycarbonates; polyesters; polystyrene; polystyrene copolymers: poly(styrene-co maleic anhydride); urea-formaldehyde; urethanes; vinyl resins: vinyl chloride-vinyl acetate copolymers, polyvinyl chloride and mixtures of two or more of these.

36. The method according to claim 2, wherein the polymer is biodegradable and is selected from the group consisting of biodegradable polyesters; starch-polyester alloys; starch; starch-PCL blends; polylactic acid (PLA)-starch blends; polylactic acid; poly(lactic acid-glycolic acid) copolymers; PCL; cellulose esters; cellulose acetate butyrate; starch esters; starch ester-aliphatic polyester blends; modified corn starch; polycaprolactone; poly(n-amylnmethacrylate); ethyl cellulose; wood rosin; polyanhydrides; polyvinylalcohol (PVOH); polyhydroxybutyrate-valerate (PHBV); biodegradable aliphatic polyesters; polyhydroxybutyrate (PHB), and biodegradable aliphatic polyester (BIONOLLE).

37. The method according to claim 5, wherein the non-migrating surfactant is selected from the group consisting of diallyl amine pluronics, linoleic alcohol derivatives, allyl alkyl phenol derivatives, acrylate derivatives, allyl alcohol alkenyl succinic anhydride derivatives, maleic derivatives, and Trem LF-40 allyl slufosuccinate derivatives.

38. A treated seed that is coated by the method of claim 1.

39. The seed of claim 38, wherein the seed is a cotton seed or a corn seed.

40. A method of protection of a seed comprising treating the seed by the method of claim 1.